



## NASA SBIR 2011 Phase I Solicitation

### X9.02 Advanced Integrated Hypersonic Entry Systems

Lead Center: ARC

Participating Center(s): GRC, JPL, JSC, LaRC

The technologies below support the goal of developing advanced integrated hypersonic entry systems that meet the longer-term goals of realizing larger payload masses for future Exploration missions.

Advanced integrated thermal protection systems are sought that address:

- Thermal performance efficiency (i.e., ablation vs. conduction).
- In-depth thermal insulation performance (i.e., material thermal conductivity and heat capacity vs. areal density).
- Systems thermal-structural performance.
- System integration and integrity.

Such integrated systems would not necessarily separate the ablative TPS material system from the underlying sub-structure, as is the case for most current NASA heat shield solutions. Instead, such integrated solutions may show benefits of technologies such as hot structures and/or multi-layer systems to improve the overall robustness of the integrated heat shield while reducing its overall mass. The primary performance metrics for concepts in this class are increased reliability, reduced areal mass, and/or reduced life cycle costs over the current state of the art.

Advanced multi-purpose TPS solutions are sought that not only serve to protect the entry vehicle during primary planetary entry, but also show significant added benefits to protect from other natural or induced environments including: MMOD, solar radiation, cosmic radiation, passive thermal insulation, dual pulse heating (e.g., aero capture followed by entry). Such multi-purpose materials or systems must show significant additional secondary benefits relative to current TPS materials and systems while maintaining the primary thermal protection efficiencies of current materials/systems. The primary performance metrics for concepts in this class are reduced areal mass for the combined functions over the current state of the art.

Integrated entry vehicle conceptual development is sought that allow for very high mass ( $> 20$  mT) payloads for Earth and Mars entry applications. Such concepts will require an integrated solution approach that considers: TPS, structures, aerodynamic performance (e.g., L/D), controllability, deployment, packaging efficiency, system robustness/reliability, and practical constraints (e.g., launch shroud limits, ballistic coefficients, EDL sequence requirements, mass efficiency). Such novel system designs may include slender or winged bodies, deployable or inflatable entry systems as well as dual use strategies (e.g., combined launch shroud and entry vehicle). New

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concepts are enabling for this class of vehicle. Key performance metrics for the overall design are system mass, reliability, complexity, and life cycle cost.

Advances in Multidisciplinary Design Optimization (MDO) are sought specifically in application to address combined aerothermal environments, material response, vehicle thermal-structural performance, vehicle shape, vehicle size, aerodynamic stability, mass, vehicle entry trajectory/GN&C (Guidance, Navigation and Control), and cross-range, characterizing the entry vehicle design problem.

Technology Readiness Levels (TRL) of 2-3 or higher are sought.